6.4 THE 10 DAY FIRE POTENTIAL ASSESSMENT

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1. INTRODUCTION

Monthly and seasonal assessments of potential fire severity (based on climatology, fire occurrence records, 30-day and 90-day weather forecasts) have become widely used over the past few years in long-range planning and resource allocation for wildland fires. In the short term, the National Fire Danger Rating System (NFDRS) Deeming (1978), based on 24-hour weather trends, is used to determine the next day's fire resource staffing level. However, no information is currently available in the mid-term (10-day) time frame, leaving fire managers to determine fire risks based upon very generalized weather forecasts. In addressing this need, the Predictive Services staff at the Northwest Interagency Coordination Center has developed a method for assessing potential fire severity in 10-day increments throughout the summer fire season.

2. ASSESSMENT PROCESS

The assessment process involves three steps: 1) analyzing medium range weather models through the 10-day period to identify critical fire weather days, 2) inputting model temperature and relative humidity guidance into the NFDRS calculator of the Fire Family Plus computer program and, 3) comparing NFDRS outputs from Fire Family Plus with climatology and historical values associated with large fires. The final Fire Potential Assessment is formatted as a text product and posted on the Northwest Interagency Coordination Center's web page.

2.1 ANALYZING MEDIUM RANGE MODELS

A wide variety of medium range models are evaluated on a daily basis with the intent of identifying known critical fire weather patterns that may develop in the 10-day period. Weather patterns of interest include those that can significantly increase the threat of large and dangerous wildland fires which present safety concerns for both firefighters and the general public. Targeted patterns are those which can produce strong winds in combination with low relative humidity, dry lightning or high Haines Index values.

Models used are: the Medium Range Forecast Model (MRF), the MRF Ensemble, Aviation (AVN), European (ECMWF), Navy NOGAPS, Canadian and the United Kingdom (UKMET) models. Consistency between models and model runs is highly desirable and results in increased confidence in the accuracy of these models. In addition to the models, National Weather Service extended forecasts and forecast discussions are used to formulate the weather portion of the assessment which includes a short synopsis and daily weather highlights.

2.2 TEMPERATURE/ HUMIDITY GUIDANCE

Among the inputs needed by the NFDRS calculator in the Fire Family Plus computer program are forecasts of the daily maximum temperature and minimum humidity, as well as forecasts of the daily 24-hour rainfall amounts. Regression equations have been developed to predict temperature and humidity. Equations for precipitation are currently under development.

Preliminary Work

Preliminary work included identification of twelve climatic areas in Washington and Oregon. For each of these climatic areas a sub-network of **"unique"** Remote Automatic Weather Stations (RAWS) was identified. A simple linear correlation methodology was used to develop this sub-network. This ensured a network comprised of RAWS which were unique amongst themselves, (i.e. they were poorly correlated with one another), while also representing all other RAWS of the area to a high degree, as defined by the developer. The method resulted in a network of 77 RAWS.

Once these 77 "key" RAWS were identified, multiple regression equations were developed to predict the daily afternoon maximum temperature and minimum humidity for each station.

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Equation Development

A "perfect prog" approach was applied. In this style approach the observed predictand (what is being forecasted) is related to weather predictors *"observed"* near the time of the observed predictand. The resulting equations are then applied operationally to make all predictions for that particular time period valid regardless of the projection.

A forward stepwise linear regression procedure was used to derive the perfect prog equations. Each equation related an observed predictand to predictors from the NWS ETA model.

The predictand variables were the daily afternoon maximum temperature (Tx) and minimum humidity (Hn) for each of the 77 key RAWS for the period of April 1, 1998 through October 20, 2000. This data is routinely retrieved by our office from the U.S. Forest Service Weather Information and Retrieval System (WIMS).

The *"observed"* weather predictors were not true observations but rather 00 hour *initialized* model grid point fields from the 00 UTC run of the NWS ETA model. Data from various initialized ETA fields were extracted from NetCDF files and interpolated to a 20-point latitude/longitude grid that covers Washington and Oregon. Model fields (predictors) used in development of the equations varied somewhat for individual RAWS but included the following:

Predictand	Predictors
Tx	850mb temperature (T8) 850mb relative humidity (R8) Surface pressure gradients Cosine of the day of the year
Hn	Tx 850mb relative humidity (R8) Surface pressure gradients

Equation Characteristics

a. Afternoon Maximum Temperature (Tx)

The T8 predictor turned up in every equation and, except in the case of a few coastal locations, was easily the best predictor. The R8 predictor was also evident in most equations. Surface pressure gradients and the cosine predictor were less prevalent in the equations and were confined to certain unique areas. For example, surface pressure gradients tended to be influential predictors of Tx in coastal areas where the extent of low level marine air, as dictated by the strength of "onshore" vs. "offshore" pressure gradients, is very important. On the other hand surface pressure gradients were rarely significant predictors east of the Cascade mountain range. The cosine predictor for the seasonal period represented by these equations rarely showed up in equations for higher elevation slope and ridge locations, but was often significant in valleys where the length of the day is a factor in "erosion" of surface inversions. The multiple correlation coefficients (R) for the Tx equations tended to be between .900 and .950 for individual RAWS, except for coastal sections where they generally ran between .850 and .900. The standard error of estimate for the equations generally ran between 3.0 and 4.0 degrees Fahrenheit west of the Cascade mountains and between 2.0 and 3.0 degrees east of the mountains.

b. Afternoon Minimum Humidity (Hn)

Tx was used as a predictor for Hn in order to ensure a certain consistency between these related predictands. In most instances, either Tx or R8 was the best predictor and both predictors normally showed up in the Hn equations. Again, as in the case with the Tx equations, the surface pressure gradients were influential predictors in coastal areas, but not east of the Cascade mountains. Performance characteristics for the Hn equations were not quite as good as for the Tx equations. Multiple correlation coefficients for the equations typically ranged between .800 and .900 and were better east of the Cascades than west. The standard error of estimate for the Hn equations was in the 10-13% range west of the Cascades and 6-10% east of the Cascades.

Operational Application of the Equations

A computer program was developed to apply the regression equations in predicting the daily Tx and Hn through 10 days for each of the 77 RAWS compromising the key RAWS network. The output includes outlooks for each individual RAWS as well as a summary table showing the predicted "average" and "extreme" daily Tx and Hn for each of the climatic areas for the next 10 days. This summary table is used as guidance input into the NFDRS calculator of Fire Family Plus when making the 10-day assessments.

Input predictors for the guidance program come from grid data fields extracted daily from the 12 UTC run of the ETA and AVN models with appropriate MRF extensions to 10 days.

An example of the summary table portion of the program output is provided in Table 1 on the following page.

09/05/2001
Model Run: 1200 UTC ETA/MRF

Area Average Tx and Hn

		We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr
Olympics	Tx	62	63	71	80	76	62	61	68	72	76
	Hn	66	62	42	30	48	65	60	47	44	40
N Coastal	Tx	59	66	73	80	75	57	62	70	74	76
	Hn	71	55	37	30	46	72	59	46	40	39
S Coastal	Tx	64	74	80	82	73	60	72	78	80	80
	Hn	62	41	32	30	54	71	41	34	33	36
WA Cscds	Tx	58	62	69	79	76	54	58	67	72	76
	Hn	78	69	45	27	43	80	63	49	42	37
OR Cscds	Tx	57	69	75	85	78	53	64	74	80	82
	Hn	71	42	32	15	37	76	47	30	21	23
SW OR Int	Tx	68	77	84	89	82	67	78	82	87	87
	Hn	45	29	28	18	29	56	28	24	20	22
NE WA Mtns	Tx	70	69	69	80	83	58	63	69	74	79
	Hn	34	33	26	20	20	48	31	22	23	21
Col Basin	Tx	72	74	73	85	88	64	67	73	79	84
	Hn	29	24	21	13	16	40	26	19	17	15
N Ctrl	Tx	61	69	72	83	82	59	62	70	77	81
	Hn	41	30	26	17	22	46	33	27	20	19
S Ctrl OR	Tx	64	69	77	86	81	64	71	76	82	83
	Hn	29	22	20	13	17	37	21	18	14	15
Blue Mtns	Tx	61	65	67	81	85	63	61	68	76	81
	Hn	35	24	28	15	11	31	26	20	14	12
SE OR	Tx	67	65	71	83	85	71	67	73	80	83
	Hn	27	25	25	14	10	26	20	18	13	11

Table 1. Temperature and Relative Humidity Guidance

2.3 FIRE FAMILY PLUS (Enhancements to the Fire Danger Projection application of Fire Family Plus 2.0)

Fire Family Plus 2.0 allows users to analyze weather and fire occurrence data. Among the application's many features is a Fire Danger Projection feature, that allows users to calculate National Fire Danger Rating (NFDR) indexes and components in the future. Instructions for working with Fire Danger Projections in Fire Family Plus 2.0 are available in the User's Guide, available at: www.fs.fed.us/fire/planning/nist/distribu.htm#Distribution.

The Predictive Services section follows these instructions, with two additional enhancements, in order to estimate NFDR severity indexes and components at ten day intervals.

1.) Using the "Stats Table" function of the Climatology Option in Fire Family, we have identified various percentiles for temperature, relative humidity and wind speed for selected Remote Automated Weather Stations (RAWS). The maximum temperature and minimum relative humidity values predicted by T. Marsha's analysis allows us to select the percentile that best represents the next ten day's maximum temperature and minimum relative humidity. We insert these percentiles in the Fire Danger Projection application before selecting the outputs and adding days.

2). After adding the next ten days, and before calculating the outputs, we adjust the climatological values for maximum temperature and minimum relative humidity using the values from Marsha's analysis. We can also add precipitation amount and duration, state of the weather, and other weather variables to calculate the fire danger projections. The calculated severity outputs thus reflect both climatology (with more accurate percentiles) and predicted weather.

3. FINAL PRODUCT

Once the NFDRS output for ERC and 1,000 hr fuel moisture are calculated through the ten day period using Fire Family Plus, the final product is composed and posted to the web. Assessments are generated for each of the seven Preparedness Zones (Figure 1) in the Northwest Geographic Region.

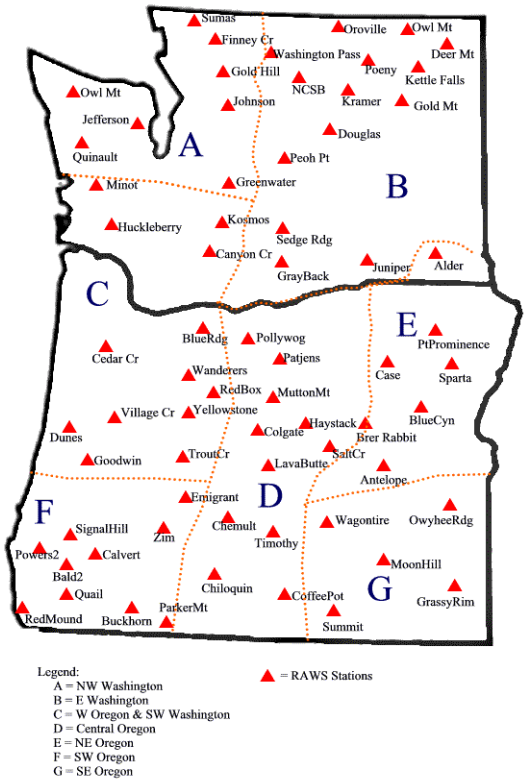

Figure 1. Northwest Preparedness Zones

The format includes a short weather synopsis, daily fire weather highlights, ERC and 1,000 hr fuel moisture information and an assessment of fire potential and weather during the ten day period (See example following this manuscript). The ERC and 1,000 hr fuel moisture information is presented in a table that displays climatological values for the date, current readings, critical values for large fires and projected values at the end of the ten day period. The product is updated every four or five days.

4. SUMMARY

The 10 Day Fire Potential Fire Assessment produced by the Predictive Services Branch of the Northwest Interagency Coordination Center is an integral component of a total assessment process that also includes seasonal and monthly assessments. Fire managers use this product in strategic planning to move and allocate firefighting resources. It was effectively used during the 2001 fire season to pre-position crews, equipment and overhead teams to specific areas of the Pacific Northwest in anticipation of critical fire weather events.

5. REFERENCES

Deeming, John E., Robert E. Burgan, and Jack D. Cohen. The National Fire-Danger Rating System – 1978. USDA Forest Service General Technical Report INT-39, Intermountain Forest and Range Experiment Station, Ogden, UT.

(Example)

10 - DAY FIRE AND WEATHER ASSESSMENT
EASTERN WASHINGTON
PREPAREDNESS ZONE B
for Tuesday September 4 through Thursday September 13, 2001

Weather Discussion...

An upper trough and surface cold front will move across eastern Washington Wednesday. The main energy with system will likely pass to the south across Oregon. However, it should still have enough strength for some mountain showers. High pressure rebuilds Thursday through the coming weekend. Another front and upper trough will slide across the area next Monday and Tuesday with a threat of showers.

Weather Outlook... For planning purposes only. Consult daily NWS forecasts for operational use.

Tuesday	(9/04)	Mostly cloudy except for some sunshine in the southeast. Slight chance of mountain showers overnight. Highs in the 70s and 80s.
Wednesday	(9/05)	Mostly cloudy with a few mountain showers. Locally gusty winds. Cooler. Highs in the 70s to near 80.
Thursday	(9/06)	Partly cloudy and locally breezy. Highs in the upper 60s to upper 70s.
Friday	(9/07)	Sunny and a little warmer. Highs in the 70s to mid 80s.
Saturday	(9/08)	Sunny and warm. Highs in the mid 70s and 80s.
Sunday	(9/09)	Mostly sunny and locally breezy. A little cooler. Highs in the 70s to lower 80s.
Monday	(9/10)	Partly cloudy and breezy. Slight chance of mountain showers. Highs in the mid 60s to mid 70s.
Tuesday	(9/11)	A mixture of clouds and sunshine. Chance of mountain showers. Highs in the mid 60s and 70s.
Wednesday	(9/12)	Mostly sunny. Highs in the 70s to near 80.
Thursday	(9/13)	Partly cloudy. Highs in the 70s to around 80.

1000 hr Fuel Moisture Outlook 9/04 - 9/13 - Fuel Model C

Climatology	9/03 Obs	Critical Value	10 Day Forecast
E Wa 12%	10%	13%	11%

ERC Outlook - Fuel model C

Climatology	9/03 Obs	Critical Value	10 Day Forecast
E WA 8	15	10	13

Fire Danger Assessment.

Dry through the period except for a chance of light mountain showers tonight and Wednesday and again next Monday and Tuesday. Slow recovery of severity indexes continues. Both ERC and 1000 hr remain beyond the value associated with large fires. Fires could still challenge initial attack.